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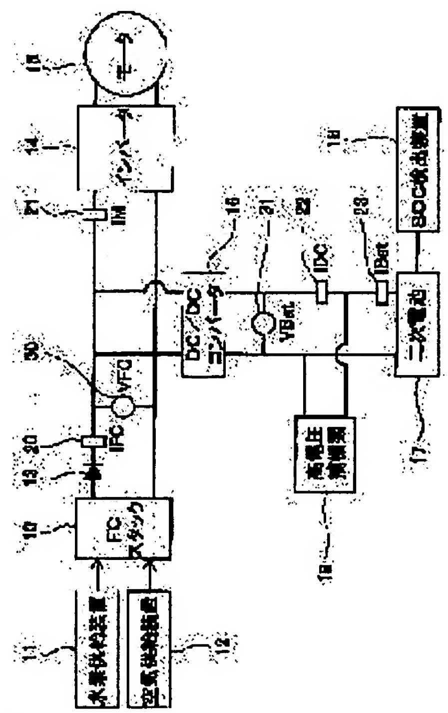
(54) FUEL CELL SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel cell system capable of calculating a power generation target of a fuel cell without being affected by an error in power consumption, and the like, occurring in each power consuming apparatus.
SOLUTION: This system is provided with a secondary battery 17 parallel connected to the fuel cell 10, a voltage converter 16 provided between the fuel cell 10 and the secondary battery 17 for adjusting the output voltage of the fuel cell 10, a plurality of current sensors 20 to 22 for detecting a current on the input side of the voltage converter 16 and a current on the output side thereof, and a pair of voltage sensors 30 and 31 for detecting a voltage on the input side of the voltage converter 16 and a voltage on the output side thereof. The conversion efficiency of the voltage converter 16 is calculated based on the input and output side currents detected by the sensors 20 to 22 and the input and output side voltages detected by the sensors 30 and 31. The power generation target of the fuel cell is calculated by using this conversion efficiency.



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CLAIMS

[Claim(s)]
[Claim 1] The fuel cell which generates electrical energy by the chemical reaction of hydrogen and oxygen (10), It connects with said fuel cell (10) in juxtaposition. The rechargeable battery in which charge and discharge are possible (17), The electrical-potential-difference converter which is prepared between said fuel cells (10) and said rechargeable batteries (17), and adjusts the output voltage of said fuel cell (10) (16), Two or more current sensors which detect the current value of the input side of said electrical-potential-difference converter (16), and the current value of an output side (20-22), It has the voltage sensor (30 31) of the pair which detects the electrical-potential-difference value of the input side of said electrical-potential-difference converter (16), and the electrical-potential-difference value of an output side. The input-side current value and output side current value of said electrical-potential-difference converter (16) which were detected in said current sensor (20-22), The fuel cell system characterized by computing the conversion efficiency of said electrical-potential-difference converter (16) based on the input-side electrical-potential-difference value and output side electrical-potential-difference value of said electrical-potential-difference converter (16) which were detected in said voltage sensor (30 31).

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention applies [to mobiles, such as a car, a vessel, and a portable electric organ,] about the fuel cell system which consists of a fuel cell which carries out electrical energy generating by the chemical reaction of hydrogen and oxygen and is effective.
[0002]
[Description of the Prior Art] For example, in the fuel cell system carried in a car, since the load power needed for car transit changes rapidly according to the transit pattern of operators, such as acceleration and deceleration, it serves as a system configuration which can carry out adjustable [of the generated output of a fuel cell] according to load power.
[0003] However, since the speed of response of the control of flow of the hydrogen used as a fuel and air is slow, it is difficult to make the generated output of a fuel cell correspond to the load power of the car which changes remarkably. For this reason, in the fuel cell system for mount, a rechargeable battery is connected to a fuel cell through an electrical-potential-difference transducer (DC to DC converter), and it has become the system configuration to which a rechargeable battery pays temporarily change of the power with which a fuel cell does not catch up.
[0004] Generated output control of the fuel cell in such a mounted fuel cell system must be controlled to compensate with all of the demand charge-and-discharge power of a rechargeable battery required in order to maintain the power consumption of high-voltage auxiliary machinery, such as inverter power and pumps for fuel supply, and the capacity of a rechargeable battery at a predetermined value, the conversion loss power of an electrical-potential-difference converter, etc.
[0005] As an example which controls such a fuel cell system, the control approach of a publication is in JP,2000-12059,A. The demand output of an inverter is computed from accelerator opening, and the fuel cell control section is calculating and controlling the generated output of a fuel cell by this approach from the output current and the output voltage property drawn based on the detected capacity. While a fuel cell is always generated on the most efficient point to capacity and supplies power to the output of an inverter, it consists of this approach so that it may compensate with the power which excess and deficiency produce by the rechargeable battery.
[0006]
[Problem(s) to be Solved by the Invention] In the fuel cell system, the total power consumption of a fuel cell system is computed, and this is considered as the target generation-of-electrical-energy output of a fuel cell. It is necessary to take into consideration the conversion efficiency f of an electrical-potential-difference transducer for calculation of the total power consumption, and this conversion efficiency f is computed in consideration of the power consumption of an inverter and high-voltage auxiliary machinery, the demand charge-and-discharge power of a rechargeable battery, etc.
[0007] The generation-of-electrical-energy output of a fuel cell needs to be in agreement with the actual total power consumption of a power consumption device. However, power consumption, such as power consumption of the inverter which is a power consumption device, and high-voltage auxiliary machinery, and demand charge-and-discharge power of a rechargeable battery, is detected for every device. For this reason, there was a problem of the total power consumption and the generated output of a fuel cell stopping being in agreement for every device of that **** under the effect of the wiring resistance between the detection error of power consumption, or a device. Moreover, since the conversion efficiency f of an electrical-potential-difference converter changed with temperature, the magnitude of a current, etc., when the value of conversion efficiency was used, it had a problem of the calculated value of the total power consumption and an actual value stopping being in agreement.
[0008] In such a case, since meals were provided with the charge-and-discharge power of the rechargeable battery currently controlled as a result according to the development of situation, cell capacity changed remarkably with time

amount progress, and when the worst, it may have lapsed into transit impossible.
[0009] This invention aims at offering the fuel cell system which can compute the target generated output of a fuel cell, without being influenced in view of the point describing above of the power consumption error generated for every power consumption device.
[0010]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, in invention according to claim 1 The fuel cell which generates electrical energy by the chemical reaction of hydrogen and oxygen (10), It connects with a fuel cell (10) in juxtaposition. The rechargeable battery in which charge and discharge are possible (17), The electrical-potential-difference converter which is prepared between a fuel cell (10) and a rechargeable battery (17), and adjusts the output voltage of a fuel cell (10) (16), Two or more current sensors which detect the current value of the input side of an electrical-potential-difference converter (16), and the current value of an output side (20-22), The input-side current value and output side current value of an electrical-potential-difference converter (16) which were equipped with the voltage sensor (30 31) of the pair which detects the electrical-potential-difference value of the input side of an electrical-potential-difference converter (16), and the electrical-potential-difference value of an output side, and were detected in the current sensor (20-22), Based on the input-side electrical-potential-difference value and output side electrical-potential-difference value of an electrical-potential-difference converter (16) which were detected in the voltage sensor (30 31), it is characterized by computing the conversion efficiency of an electrical-potential-difference converter (16).
[0011] Thereby, in case the conversion efficiency of an electrical-potential-difference converter (16) is computed, the power consumption error for every device and the power consumption error by wiring resistance can be disregarded. Thus, by using the conversion efficiency of the computed electrical-potential-difference converter (16), the target generated output of a fuel cell (10) can be computed more correctly.
[0012] In addition, the sign in the parenthesis of each above-mentioned means shows correspondence relation with the concrete means of a publication to the operation gestalt mentioned later.
[0013]
[Embodiment of the Invention] Hereafter, the operation gestalt which applied this invention is explained based on drawing 1 - drawing 6 . This operation gestalt applies the fuel cell system of this invention to an electric vehicle.
[0014] Drawing 1 shows the whole fuel cell system configuration of this operation gestalt. As shown in drawing 1 , a fuel cell (FC stack) 10, the hydrogen feeder 11, air supply equipment 12, the inverter 14, DC to DC converter (voltage adjustment means) 16, the rechargeable battery 17, and the high-voltage auxiliary machinery 19 grade are prepared in the fuel cell system of this operation gestalt.
[0015] A fuel cell (FC stack) 10 generates power using the electrochemical reaction of hydrogen and oxygen. The solid-state polyelectrolyte mold fuel cell is used as a fuel cell 10, two or more laminatings of the single cel used as a base unit are carried out, and it consists of these operation gestalten. In a fuel cell 10, by supplying hydrogen and air (oxygen), the electrochemical reaction of the following hydrogen and oxygen occurs and electrical energy occurs.
(Hydrogen pole side) The hydrogen feeder 11 for supplying hydrogen to the hydrogen pole (negative electrode) side of a fuel cell 10 and the air supply equipment 12 for supplying air (oxygen) to the oxygen pole (positive electrode) side of a fuel cell 10 are formed in the H2 ->2H++2e-(oxygen pole side)2H++1/2O2+2e-->H2O fuel cell system. The hydrogen tank which contains hydrogen storage material, such as a reformer which generates hydrogen, for example by the reforming reaction, or a hydrogen storing metal alloy, as a hydrogen feeder 11, and stores pure hydrogen can be used. As air supply equipment 12, a compressor or Blois can be used, for example.
[0016] The inverter 14 is connected to the fuel cell 10 through diode 13. Only by turning diode 13 to an inverter 14 from a fuel cell 10, it passes a current. An inverter 14 changes into alternating current the direct current supplied from a fuel cell 10, supplies it to a drive motor 15, and it is constituted so that a motor 15 may be driven.
[0017] The rechargeable battery (dc-battery) 17 in which charge and discharge are possible is connected to the fuel cell 10 in juxtaposition through DC to DC converter (voltage adjustment means) 16. DC to DC converter 16 is constituted so that an electrical potential difference may be changed between a fuel cell 10 and a rechargeable battery 17. In DC to DC converter 16, power loss occurs in the case of electrical-potential-difference conversion. When a rechargeable battery 17 charges and the output of a fuel cell 10 is insufficient, the dump power generated with the fuel cell 10 is constituted so that a part for insufficient power may be supplied from a rechargeable battery 17.
[0018] When connecting the FC stack 10 and a rechargeable battery 17 to juxtaposition and carrying out an electric power supply to an inverter 14, it is necessary to make both potential equal. So, with this operation gestalt, DC to DC converter 24 is performing electrical-potential-difference conversion so that the electrical potential difference of the FC stack 10 and a rechargeable battery 17 may become the same. Such a configuration can perform the electric power supply assignment to an inverter 14 by the FC stack 10 and the rechargeable battery 17.

[0019] The SOC detection equipment 18 which detects the residual cell capacity SOC of a rechargeable battery 17 is formed in the rechargeable battery 17. Detection of the cell capacity SOC is performed by the known approach. For example, there is a method of integrating the current value and time amount of charge and discharge, and asking for a changed part of capacity to the initial capacity of a rechargeable battery 17 or the approach of searching for from the V-I property of a rechargeable battery 17.
[0020] Drawing 2 is map data showing the target power Pchg of the charge-and-discharge power of the rechargeable battery 17 to the cell capacity SOC of a rechargeable battery 17. As shown in drawing 2 , the charge-and-discharge target power Pchg of a rechargeable battery 17 is beforehand set up so that it may change according to the cell capacity SOC of a rechargeable battery 17. With this operation gestalt, the charge-and-discharge target power Pchg is set up so that the cell capacity of a rechargeable battery 17 may become 60%. Therefore, when the cell capacity SOC is 60% or more, the target charge-and-discharge power Pchg of a rechargeable battery 17 is set as a minus value. Conversely, in not filling the cell capacity SOC to 60%, it sets the target charge-and-discharge power Pchg of a rechargeable battery 17 as a plus value.
[0021] Furthermore, the high-voltage auxiliary machinery 19 is connected to the fuel cell 10 through DC to DC converter 16. It is the equipment which consumes the power of the compressor 11 grade for air supply in the high-voltage auxiliary machinery 19. Since it is necessary to fluctuate the fuel amount of supply according to inverter demand power, the power consumption PHk of auxiliary machinery 19 is a value which carries out adjustable according to inverter demand power.
[0022] Current sensors 20-23 and voltage sensors 30 and 31 are formed in the fuel cell system of this operation gestalt. Current sensors 20-23 are arranged by the number small one piece to the branched number of wiring in the part where the current on wiring to which each device is connected branches. The current to the direction in which current sensors 20-23 are not formed is computable in other two current sensors.
[0023] The 1st current sensor 20 detects the output current value IFC of a fuel cell 10, the current value IM which flows to an inverter 14 by the 2nd current sensor 21 is detected, the current value IDC which flows from DC to DC converter 16 by the 3rd current sensor 22 is detected, and the current value IBat which flows to a rechargeable battery 17 by the 4th current sensor 23 is detected. The current value which flows to DC to DC converter 16 can be calculated by (IFC-IM), and the current value which flows to the high-voltage auxiliary machinery 19 can be calculated by (IDC-IBat).
[0024] Moreover, voltage sensors 30 and 31 are arranged in one part which becomes equipotential, when [each] DC to DC converter 16 is inserted and the wiring resistance in the input side and output side of DC to DC converter 16 is disregarded. The 1st voltage sensor detects the electrical-potential-difference value VFC by the side of a fuel cell 10, and the 2nd voltage sensor detects the electrical-potential-difference value VBat by the side of a rechargeable battery 17.
[0025] Drawing 3 shows the control unit 40 of the fuel cell system of this operation gestalt. The control unit 40 shown in the fuel cell system of this operation gestalt at drawing 3 is formed. A sensor signal inputs into a control device 40 from various sensors, and it is constituted so that a control signal may be outputted to each device of DC to DC converter 16 grade.
[0026] Next, actuation of the fuel cell system of this operation gestalt is explained based on drawing 4 - drawing 6 . Drawing 4 is a flow chart which shows actuation of a fuel cell system. The following control is performed repeatedly a predetermined period.
[0027] First, the transit target power FPower is computed based on signals, such as a car operator's accelerator opening, (step S10). This transit target power FPower turns into the demand output (target output) PMo of an inverter 14. Next, current sensors 20-23 and voltage sensors 30 and 31 detect the current values IFC, IM, and IDC of each part of a fuel cell system and the electrical-potential-difference value VFC, and VBat (step S11).
[0028] Next, with SOC detection equipment 18, the cell capacity SOC of a rechargeable battery 17 is detected (step S12), and the target charge-and-discharge power Pchg of a rechargeable battery 17 is found based on the map of drawing 2 (step S13).
[0029] Next, power distribution count is carried out (step S14). Power distribution count is performed as shown in drawing 5 . The actual power which flows to each device of a fuel cell 10, an inverter 14, a rechargeable battery 17, and the high-voltage auxiliary machinery 19 can be found by fuel cell power Pfc=IFCxVFC, inverter power PM=IMxVFC, rechargeable battery charge-and-discharge power PBat=IBatxVBat, and auxiliary machinery power PHk=(IDC-IBat) xVBat.
[0030] The conversion efficiency (power efficiency) f of DC to DC converter 16 can be calculated by f=(VBatxIDC)/ (VFCx (IFC-IM)) from the input-side current value and the output side current value, input-side electrical-potential-difference value, and output side electrical-potential-difference value of DC to DC converter 16.

[0031] Let transit target power FPower found at the above-mentioned step S10 be the inverter target power PMo. The target power PHko of the auxiliary machinery 19 required in order to supply the air flow rate and hydrogen flow rate which are needed since a fuel cell 10 outputs the inverter target power PMo to a fuel cell 10 is found. This auxiliary machinery target power PHko is a value which becomes settled with the inverter target power PMo.
[0032] It can ask for the target generated output Pfco of a fuel cell 10 by Pfco=PMo+f (PHko+Pchg) from the conversion efficiency f of DC to DC converter 16 which is the inverter target power PMo, the auxiliary machinery target power PHko, the rechargeable battery target charge-and-discharge power Pchg, and the actual measurement which are calculated value.
[0033] Next, based on the power distribution count calculated at the above-mentioned step S14, generation-of-electrical-energy control of a fuel cell 10 is performed (step S15). Specifically, the amount of distributed gas is controlled by gas transfer units 11 and 12. Furthermore, output voltage of a fuel cell 10 is controlled by DC to DC converter 16.
[0034] Output voltage control of the fuel cell 10 by DC to DC converter 16 is based and explained in the output-characteristics Fig. of the fuel cell 10 shown in drawing 6 . g1-g3 in drawing 6 are the output characteristics of the fuel cell 10 at the time of changing the hydrogen amount of supply to a fuel cell 10, and the amount of air supply. g1 has least amount of supply, and the amount of supply has most g3. As shown in drawing 6 , g1 is an A point, g2 is a B point and, as for g3, output characteristics are changing rapidly at C point.
[0035] For this reason, in each gas supply volume, much power can be most efficiently taken out from a fuel cell 10 by generating electricity at an A-C point just before output characteristics change suddenly. Therefore, the output voltage VFC of a fuel cell 10 is controlled by DC to DC converter 16 to become the electrical potential difference which can take out power from a fuel cell 10 most efficiently in each gas supply volume.
[0036] As mentioned above, by forming current sensors 20-23 in the part where the generated output of a fuel cell 10 is distributed, and forming voltage sensors 30 and 31 in the part where an electrical potential difference becomes equipotential, in case the conversion efficiency f of DC to DC converter 16 is computed, the power consumption error for every device and the power consumption error by wiring resistance can be disregarded. Thereby, the target generated output Pfco of a fuel cell 10 can be more correctly computed now.

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* NOTICES *

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2.**** shows the word which can not be translated.
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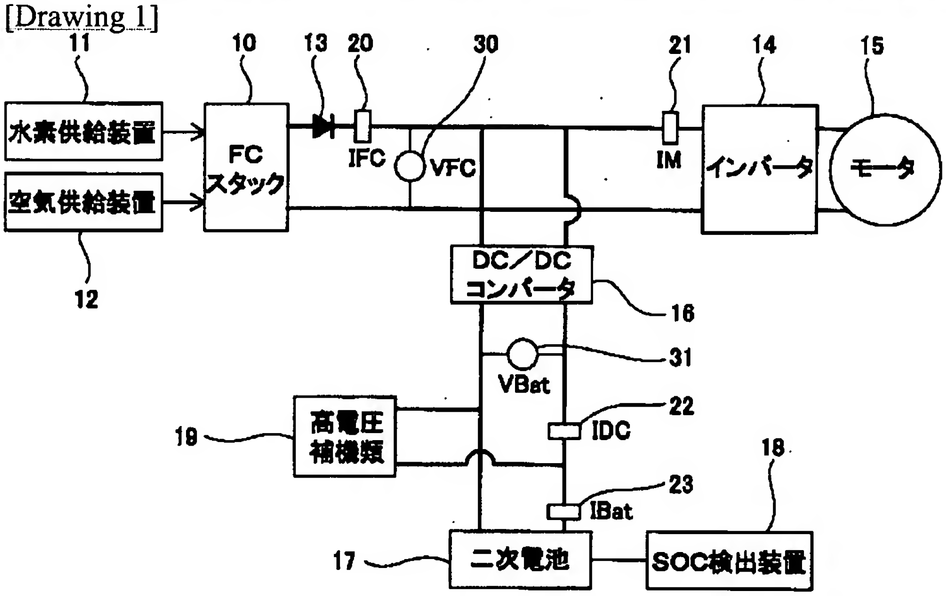
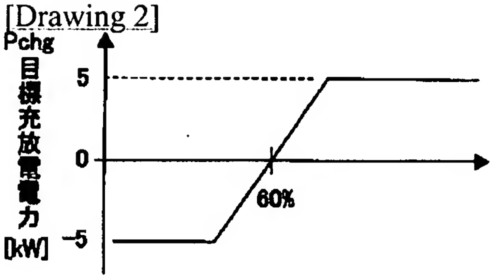
DRAWINGS

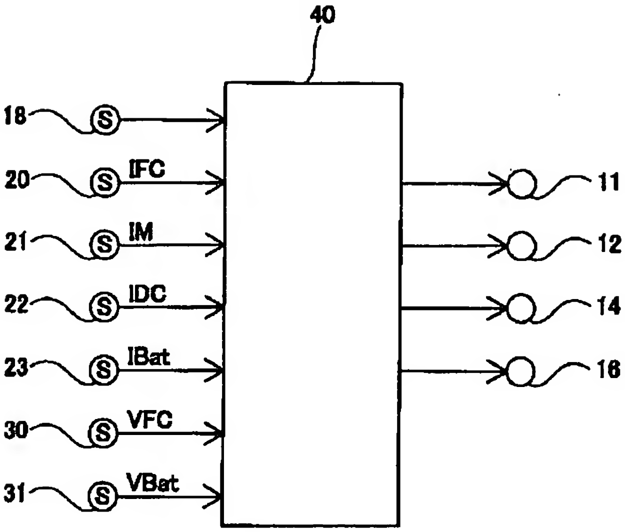
[Drawing 1]



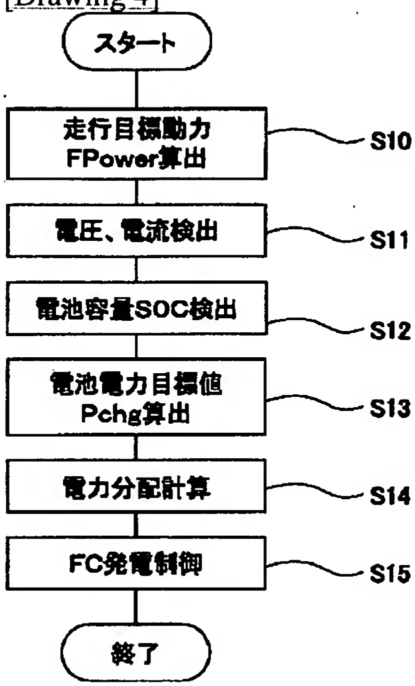
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Drawing 5]

電気分配計算

電力計算

[FC電力]

$P_{fc} = I_{FC} \times V_{FC}$

[インバータ電力]

$P_M = I_M \times V_{FC}$

[電池電力]

$P_{Bat} = I_{Bat} \times V_{Bat}$

[補機電力]

$P_{Hk} = (I_{DC} - I_{Bat}) \times V_{Bat}$

[DC／DCコンバータ変換効率]

$f = (V_{bat} \times I_{DC}) / (V_{FC} \times (I_{FC} - I_M))$

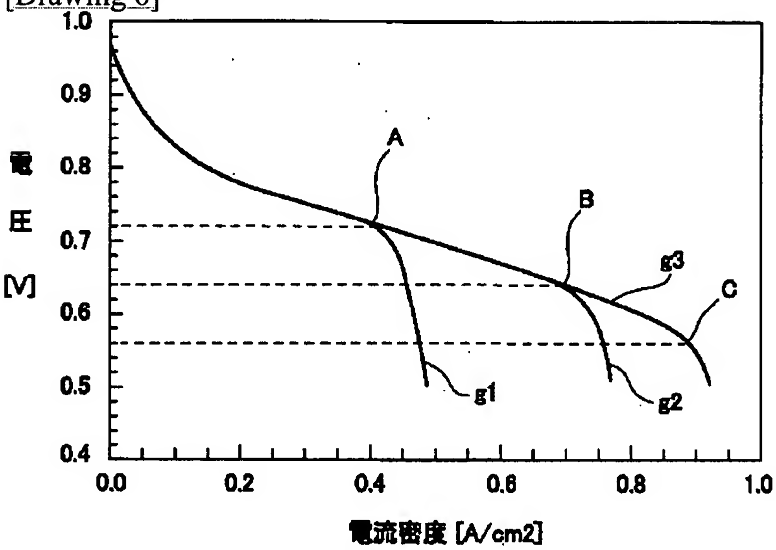
[燃料電池の発電電力]

$P_{fc} = P_M + f(P_{Hk} + P_{Bat})$

[燃料電池の目標電力]

$P_{fco} = P_{Mo} + f(P_{Hko} + P_{chg})$

[Drawing 6]



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